

# THE TRANSITION IMPERATIVE FROM BIOFUELS TO BIOREFINERIES

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# The are many challenges in transitioning to renewable biofuels

Sources of biomass

Technical challenges such as conversion

Food vs fuel

Massive volumes required

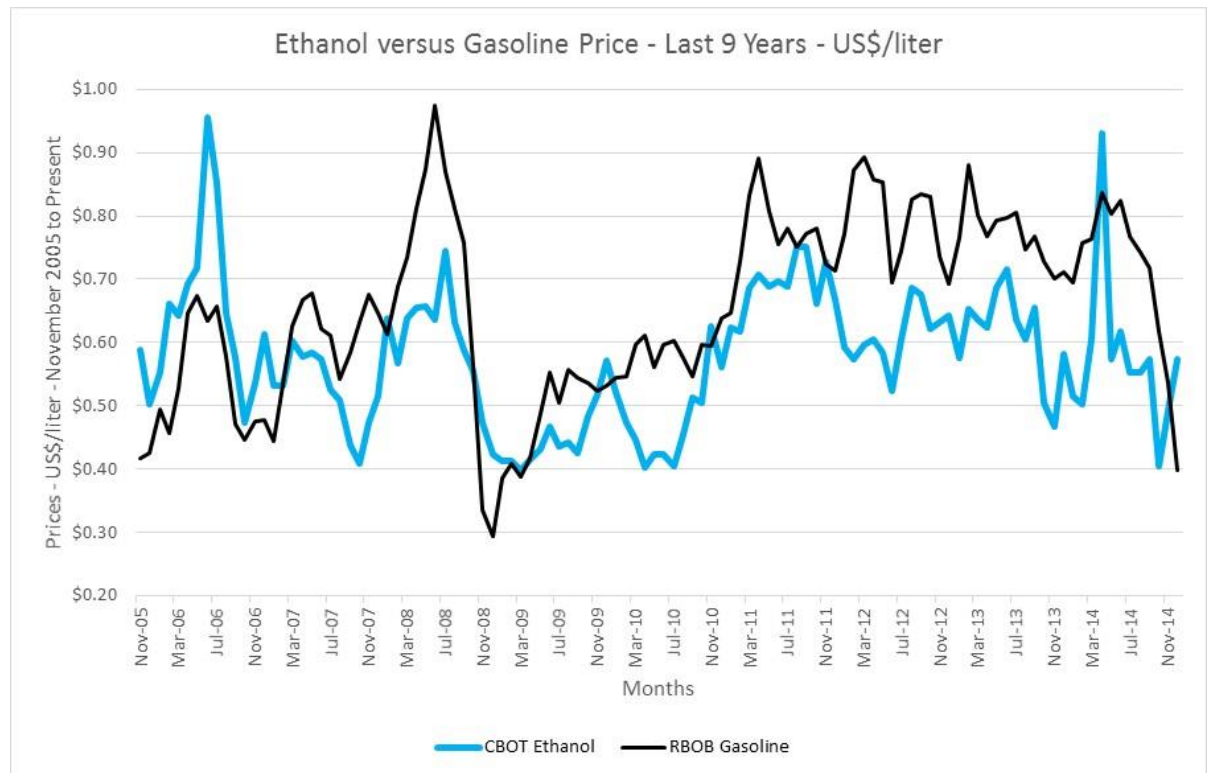
Return on investment

Cost of production

Amongst many others

However, one overriding key issue is

**The low value of fuels or high effective cost of lignocellulosic sugars**



## A key issue is the low value and high price volatility of fuels

World runs on cheap fossil fuels

Gasoline in the US is under US\$600/t

Ethanol is only about US\$700/t

Price have been

as high as US\$1,300/t

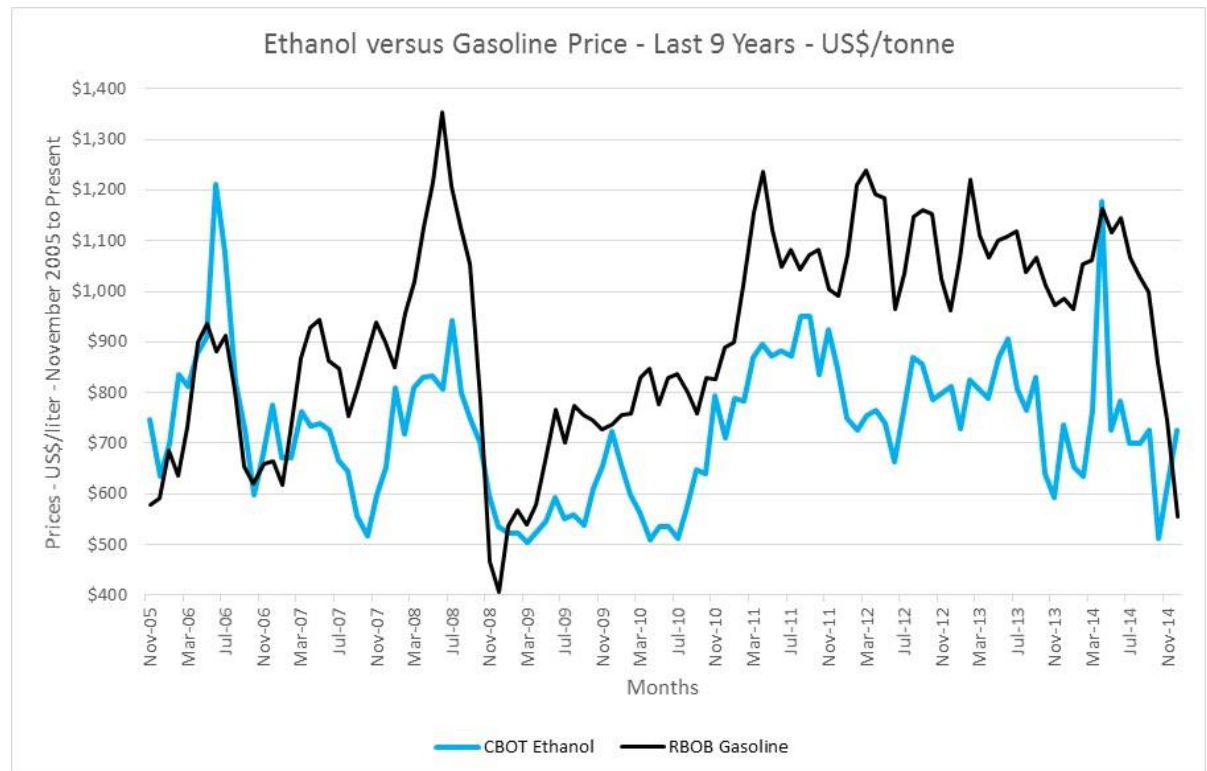
as low as US\$400/t

Average price for last 9 years is

Gasoline: US\$900/t

Ethanol: US\$720/t

**High volatility low value fuels**



## A simple analysis demonstrates the challenge...

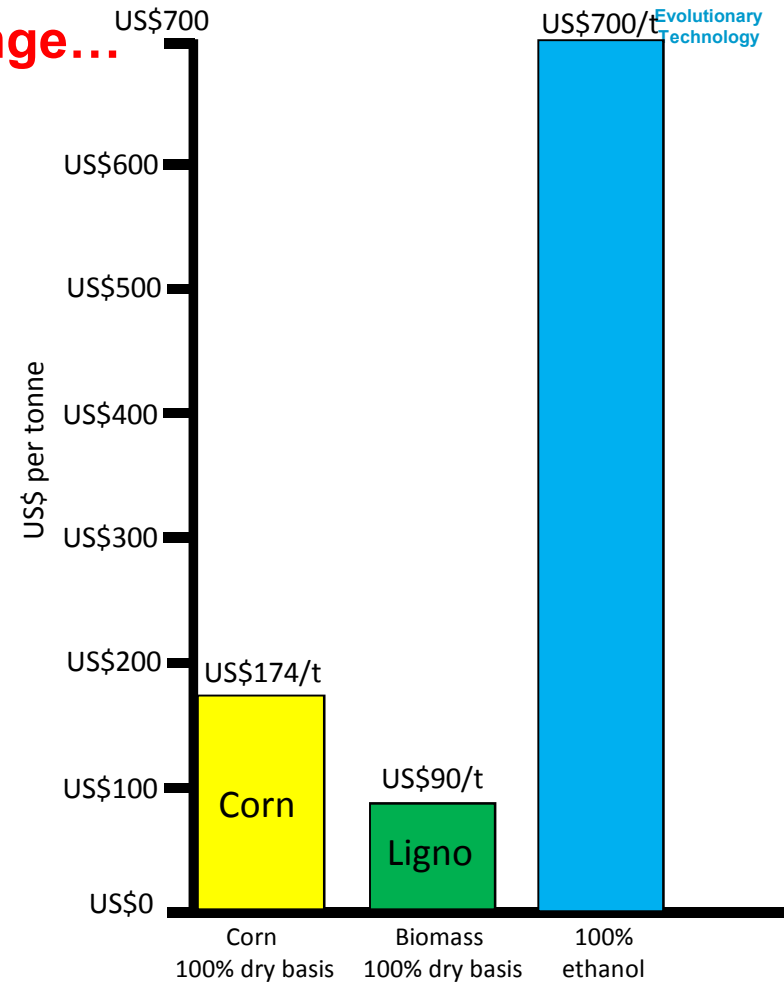
Analysis of a standard ethanol only lignocellulosic facility

Step (1)

Cost of substrate delivered = US\$90/t

Value of primary product = US\$700/t

**Cheap biomass = a very attractive start**





## Not all biomass is sugars...

Typically biomass contains lignin and ash

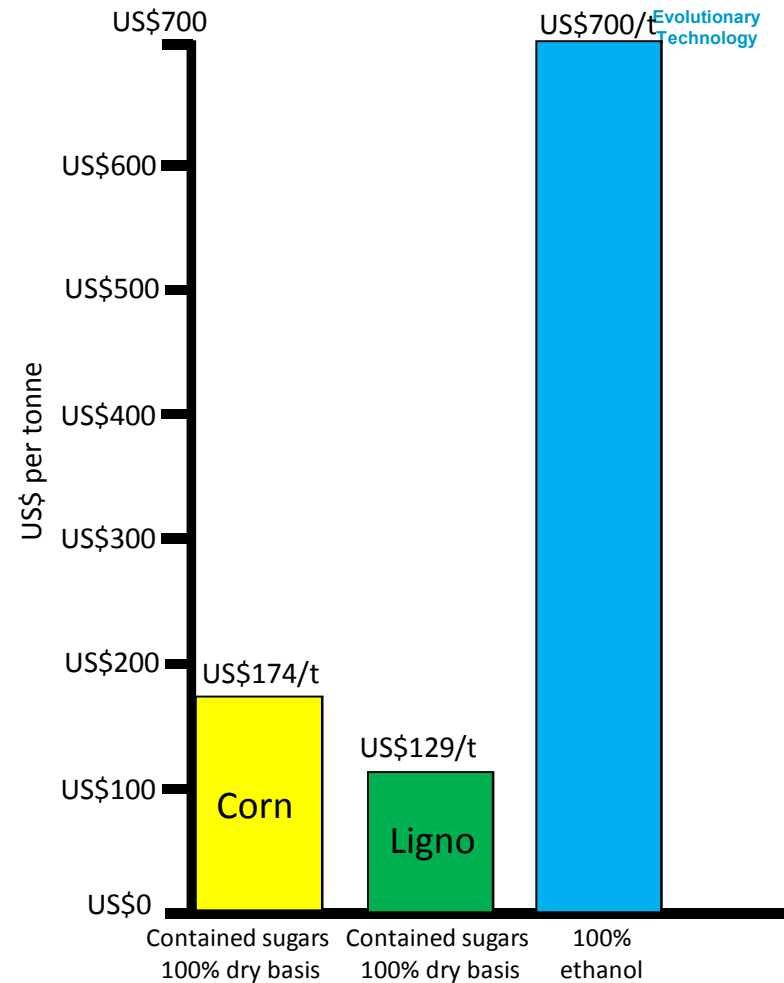
Step (2)

Only 70% of delivered biomass contains sugars

Therefore effective cost of sugars delivered is

$$US\$90/0.7 = US\$129/tonne$$

**Cheap sugars = still attractive**



**Note:** 100% of corn has value with the DDGS is worth about the same as the corn

## Losses increase effective biomass cost

Assume optimistic loss rate

Step (3)

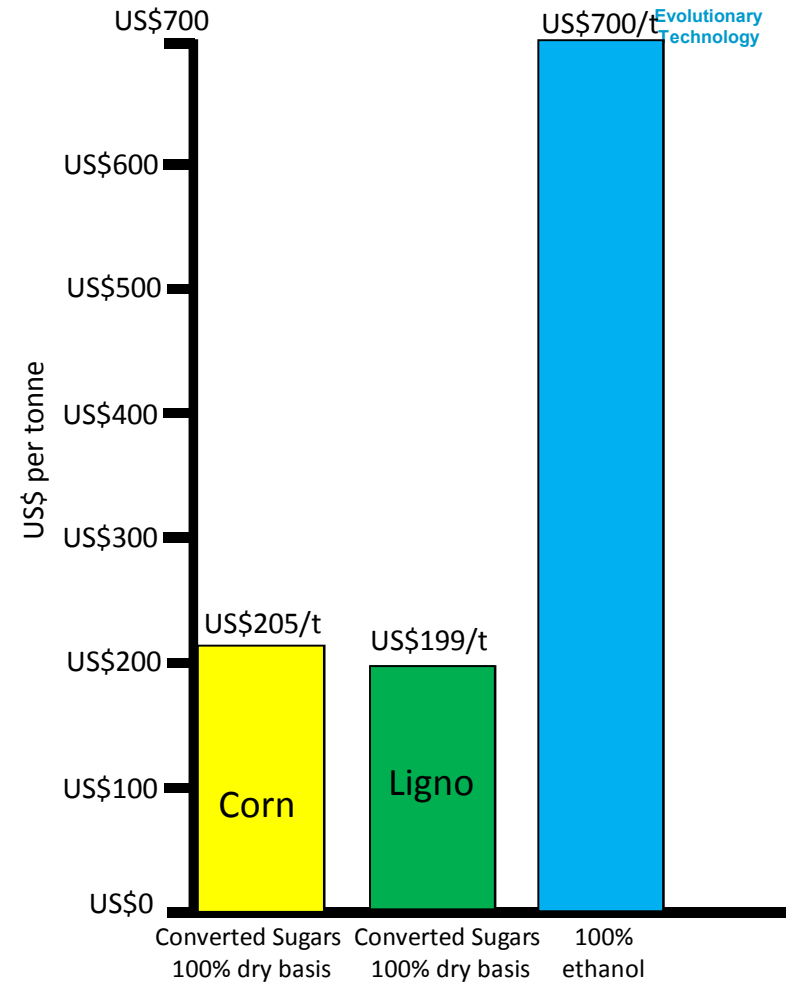
Only 65% of sugars converted to ethanol due to

- “ Unwanted glycerol produced
- “ Distillation losses
- “ Organism growth
- “ Only 80% of cellulose converted to monomers
- “ Residual sugars after fermentation

Therefore effective cost of sugars delivered is

$$\text{US\$129} / 0.65 = \text{US\$199/tonne}$$

**Cheap sugars = not really so cheap**



**Note:** Corn ethanol has less by-product glycerol, less residual sugars, lower distillation losses and less yeast required than lignocellulosic processes

## Conversion to ethanol adds to effective cost

Assume optimistic conversion rate

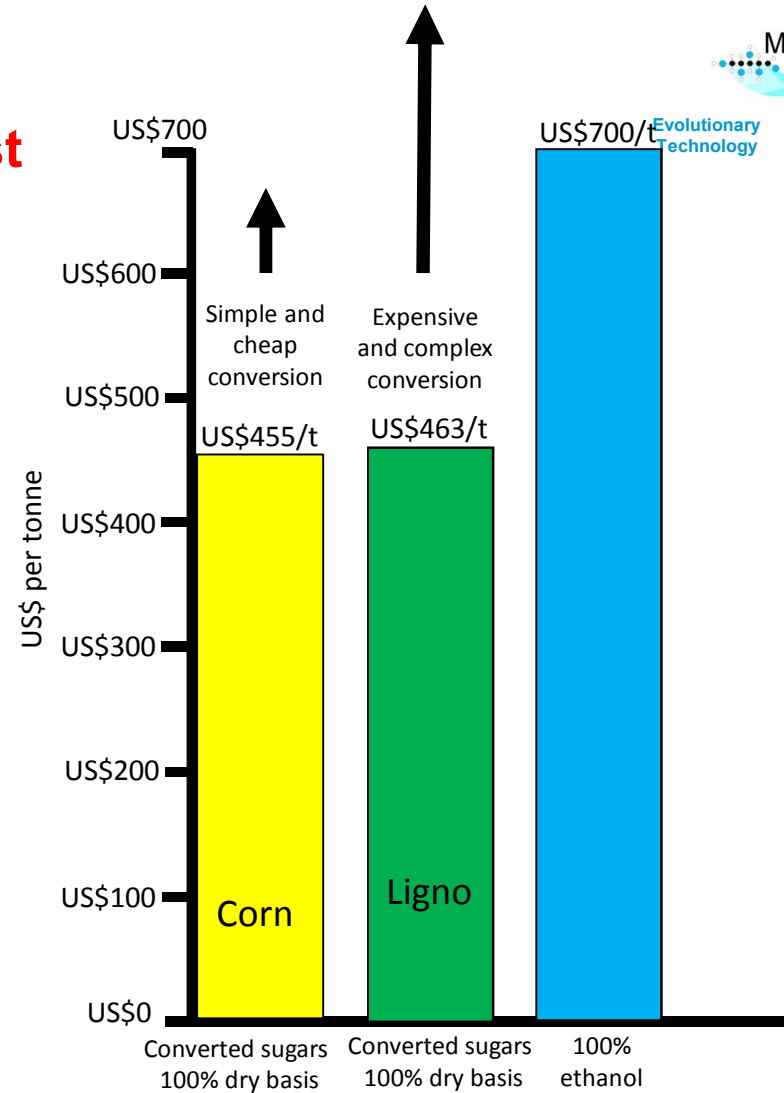
Step (4)

When yeast convert sugars they produce carbon dioxide as a by product

Optimistic conversion rate of lignocellulosic sugars is at 0.43. That is, for every 100g of sugar, 43g of ethanol is produced.

$$\text{US\$}199/0.43 = \text{US\$}463/\text{tonne}$$

**Cheap sugars = not any more**



**Note:** Corn ethanol converts at a rate of around 0.45

## High effective cost of sugars is now well understood

Industry is looking to

- “ Move to higher value products such as bio-chemicals
- “ Develop bio-refineries where more than just low value fuel is produced such as high value protein
- “ Increase conversion efficiencies to lower effective sugars costs



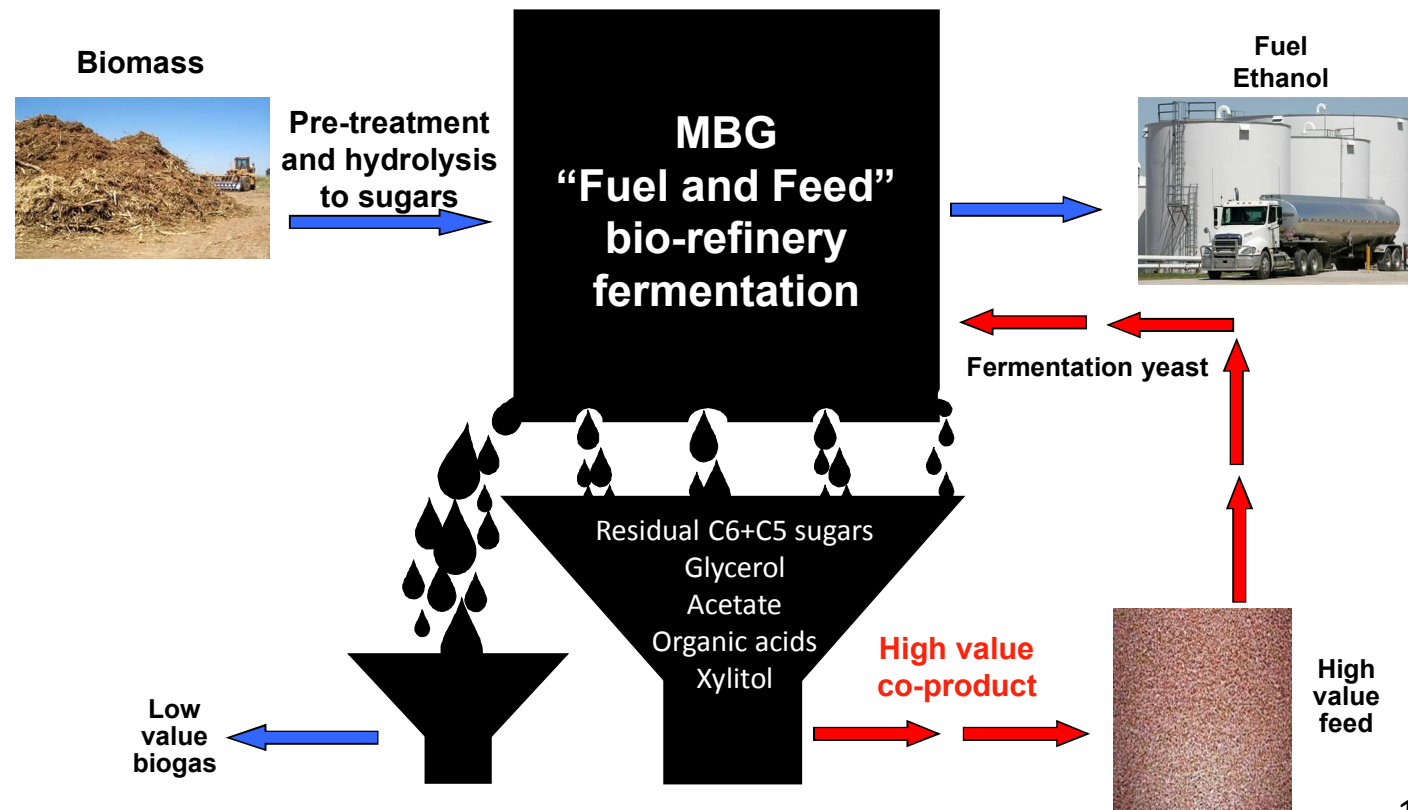
## Microbiogen solution...

- “ Yeast have been developed that can grow on their own non-sugar waste streams
- “ Process designed so that both high value yeast and ethanol are produced
- “ Yeast is a high value product and fish meal replacement. Estimated sale price US\$1,300/t.

### Result:

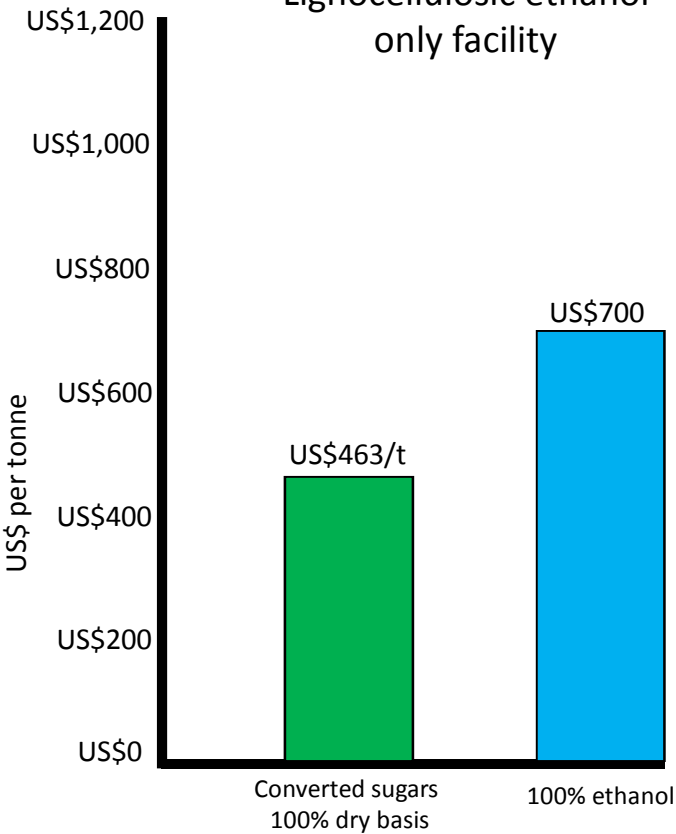
25% more product

40% higher average price

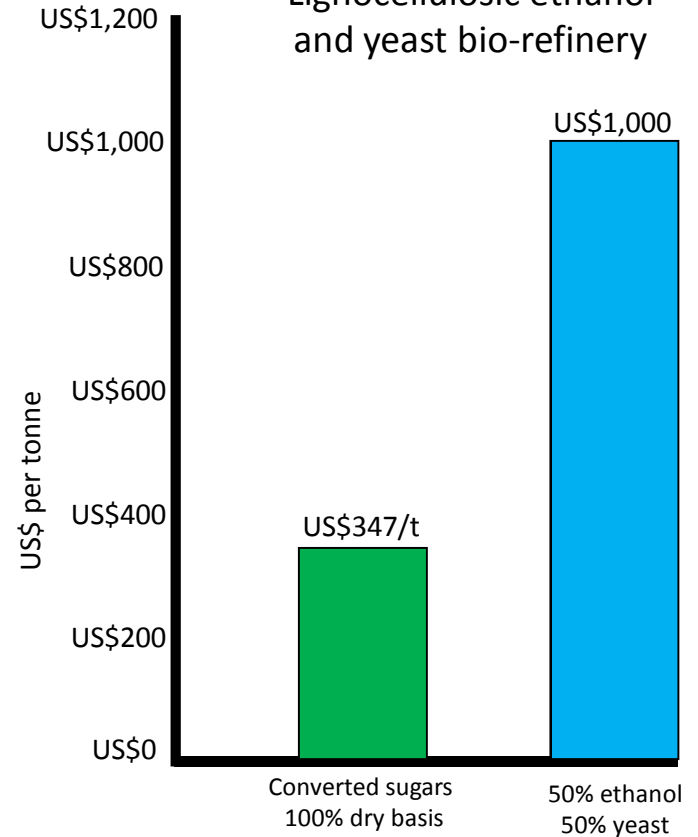


# Impact: 25% lower effective sugar cost and 40% higher price received

Lignocellulosic ethanol only facility



Lignocellulosic ethanol and yeast bio-refinery



## Questions...

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